MINERAL EXPLORATION SYMPOSIUM 2020

Seismic Imaging Schemes for Mineral Exploration: The SIT4ME view

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GEO3BCN Geosciences Barcelona - CSIC

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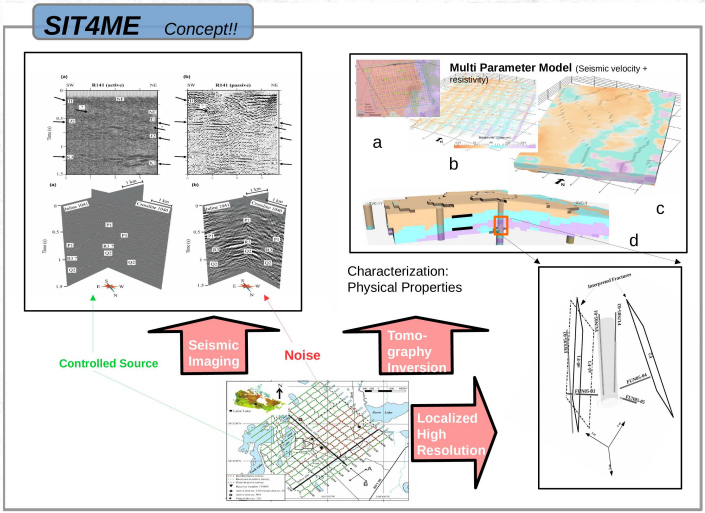
SIT4ME



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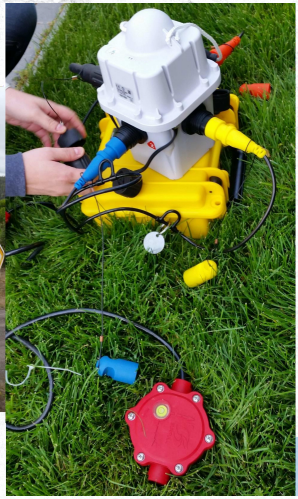
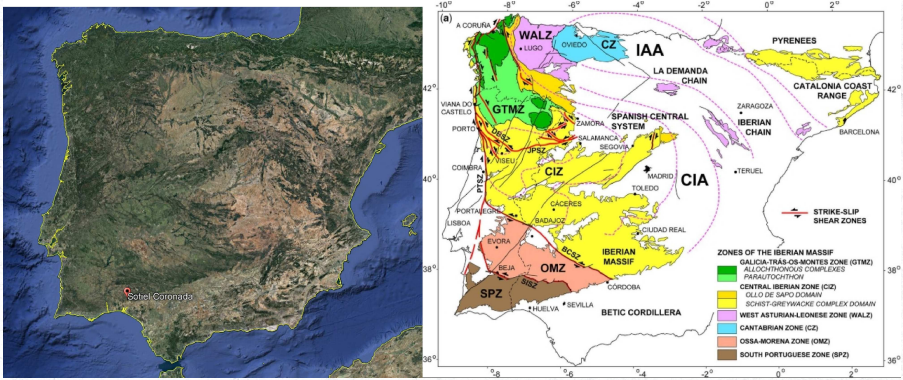
Source & Receivers



Vibroseis Source & SERCEL's RAU UNITES

General Geologic Framework



Variscan Domain within the Iberia Peninsula & location of the Iberian Pyrite Belt (IPB).

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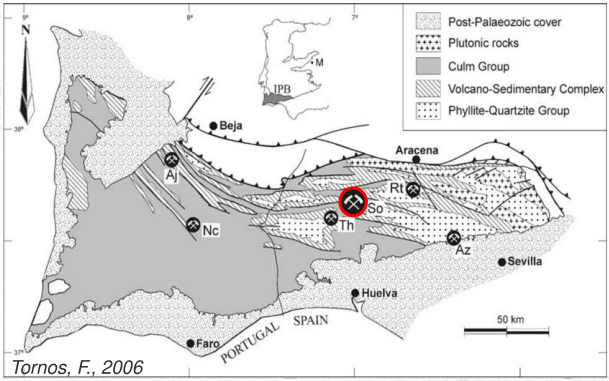
Iberian Pyrite Belt

The Volcanic Sedimentary Complex formed during the Upper Devonian (Famennian) to mid-Carboniferous (Visean). Extensional tectonic regime disrupted the siliciclastic platform in extensional graben-type basins related to continent-continent oblique collision zone, Collison: South Portuguese Zone & Ossa Morena Zone

NW-SE/W-E-trending and SW- or S-verging folds (with NE- or N-dipping planar cleavage) and thrusts, occur in west-central and eastern IPB. In late to post-Variscan time strike-slip oblique faults formed, either N-S to NNW-SSE or NE-SW to ENE-WSW, dextral or sinistral (both extensional)



Tornos, F., 2006

Iberian Pyrite Belt hosts the largest concentration of massive sulphide deposits worldwide. Simancas et al., 2013; Inverno et al., 2015

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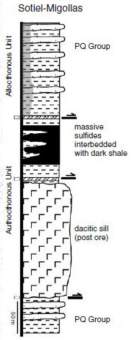
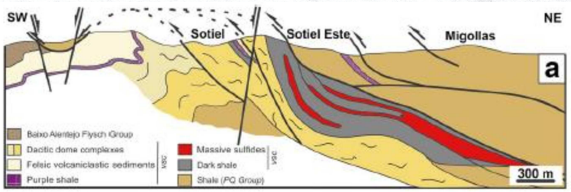
Surface Characteristics

Area characterized by highly variable topographic relief

Sotiel-Coronada Geologic Setting



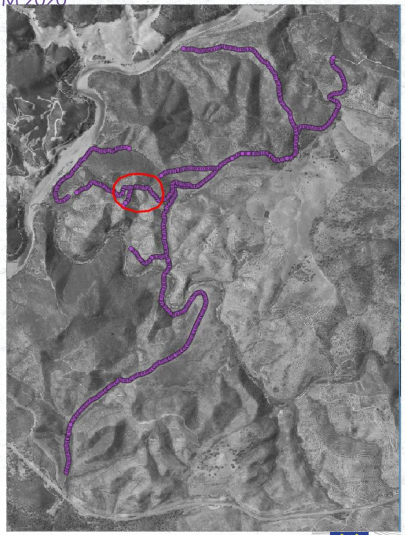
(Tornos et al., 2006)



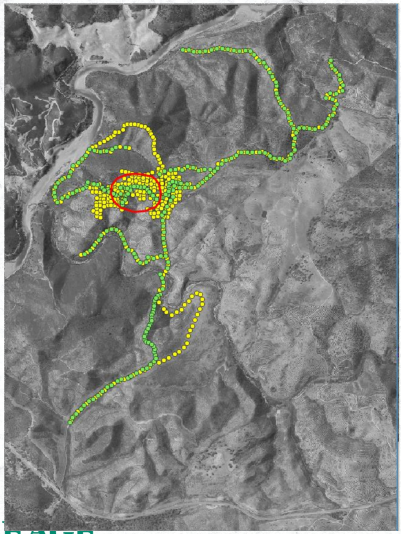
(Velasco-Acebes et al., 2018)

	Mt	%Cu	%Pb	%Zn	Ag, ppm	Au, ppm
Sotiel	75.2	0.6	1.3	3.2	24	0.2

Acquisition Geometry



Sources



Receivers (Yellow 1C, Green 3C)

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Acquisition Parameters & Fold

Sources

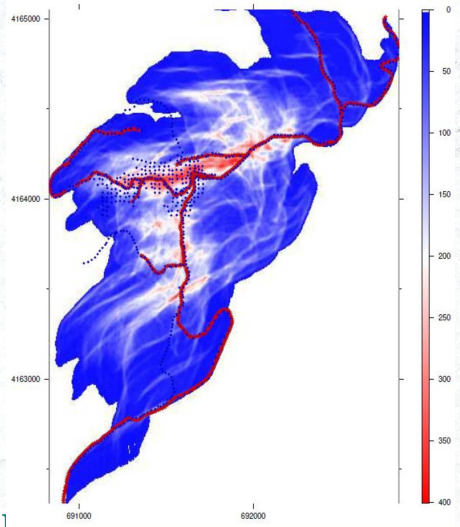
- 10 m Source Spacing
- 910 Vp's
- 10-100 Hz Sweeps (x3/VP)

Receivers

- 20 Station Spacing
- 406 1C Stations
- 247 3C Stations
- 2D + 3 D Configuration

Recording Time

- 12 Shooting Days
- 24 hrs recording



Fold Map Target area high fold.

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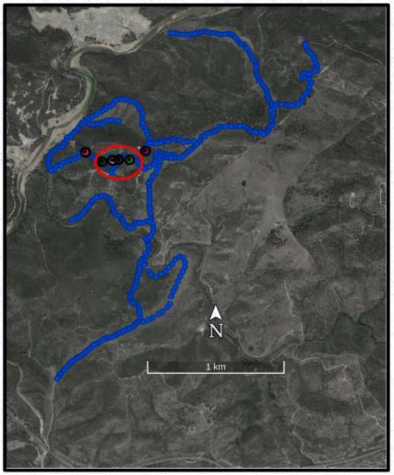
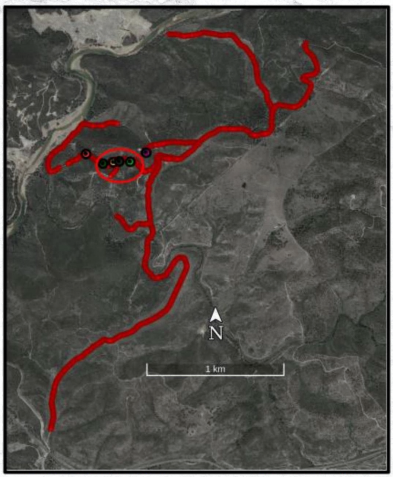
Borehole Constraints





ELV-102
ELV-04 y ELV-58
ELV-28 y ELV-30
ELV-10 y ELV-12
ELV-38 y ELV-49
ELV-49

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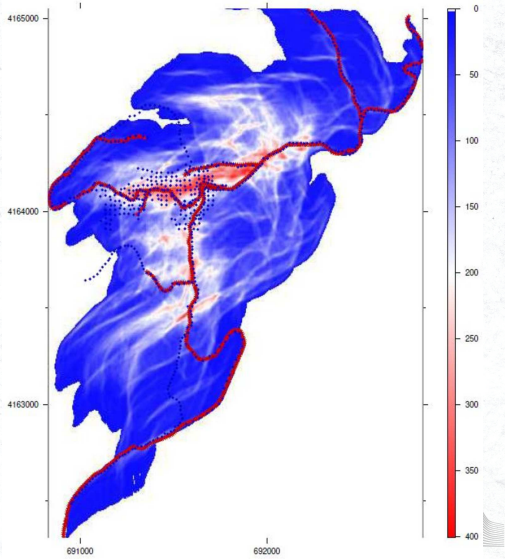
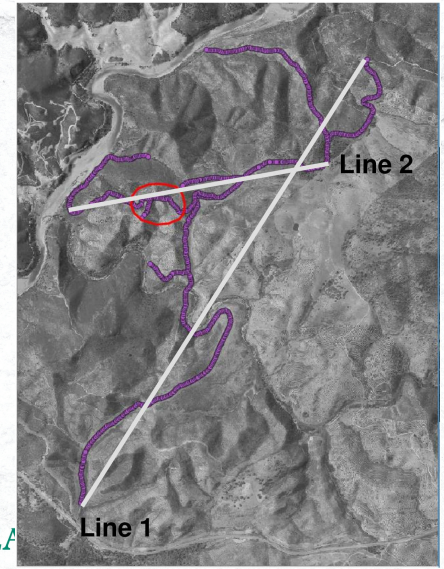


Fold Map Target area high fold.

2D Stacks



2D Stack Sections

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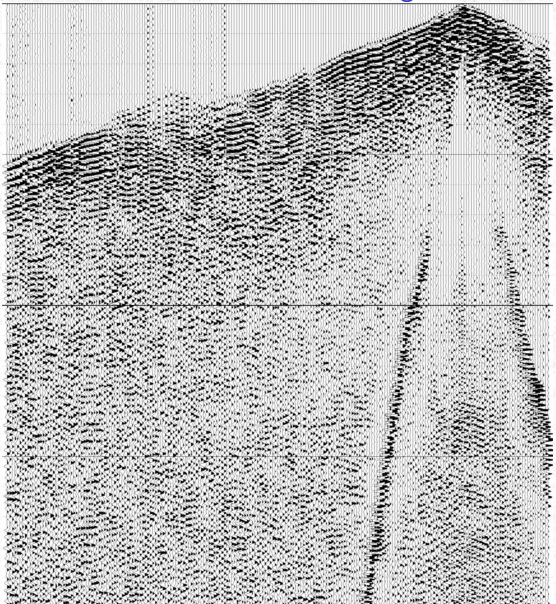
Seismic Data Processing; Shot example (i)

- Raw Shot Gather (+ AGC 1s)



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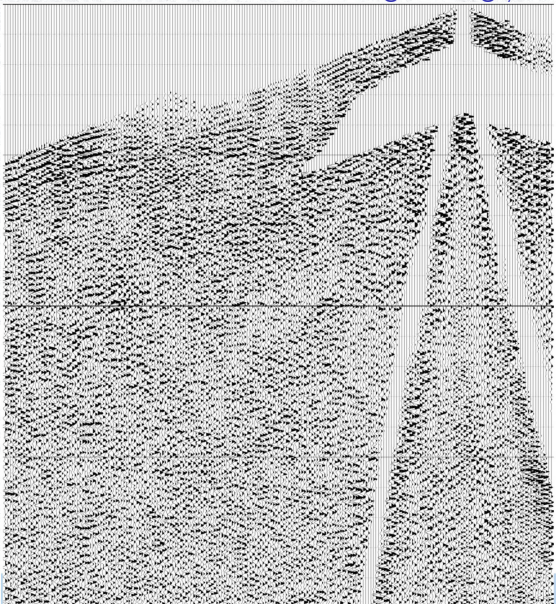
- Raw Shot Gather
- Static corrections (elevation + refraction)
- Amplitude recovery (Trace Balance + Spherical divergence)
- Frequency Filtering (Band Pass 20-30-65-90 Hz)
- Surface-consistent deconvolution (70ms Window, 4ms gap)
- Spectral balance (15-24-65-90)
- Notch (50 hz).
- Surface Wave + Airy wave surgical mute

Figure: Figs/sht03.pdf



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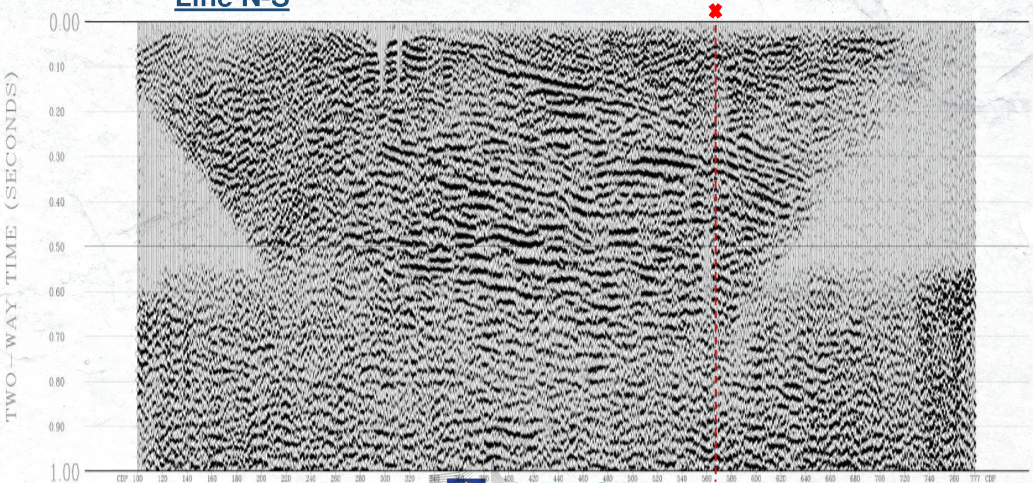
Line 1: NS Stack Section



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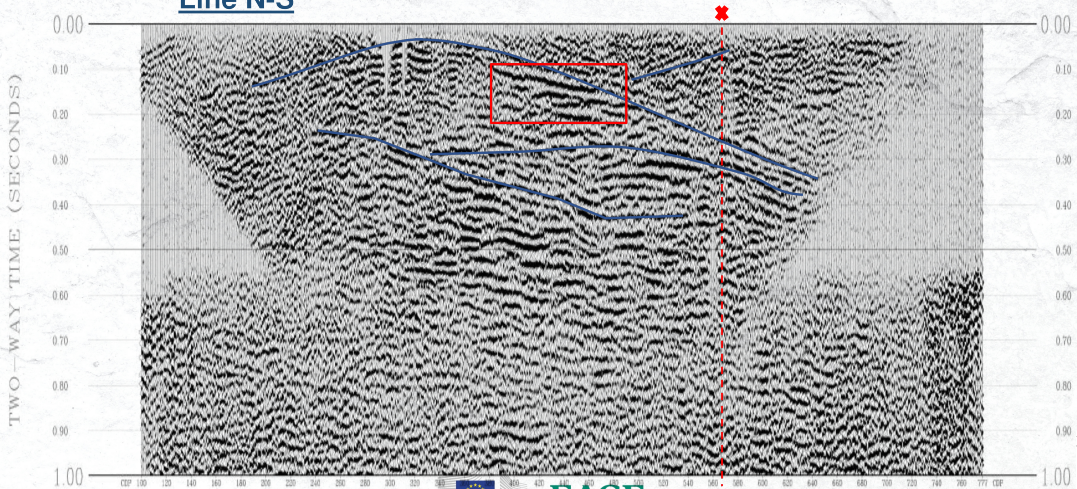
Line 1: NS Stack Section & Interpretation



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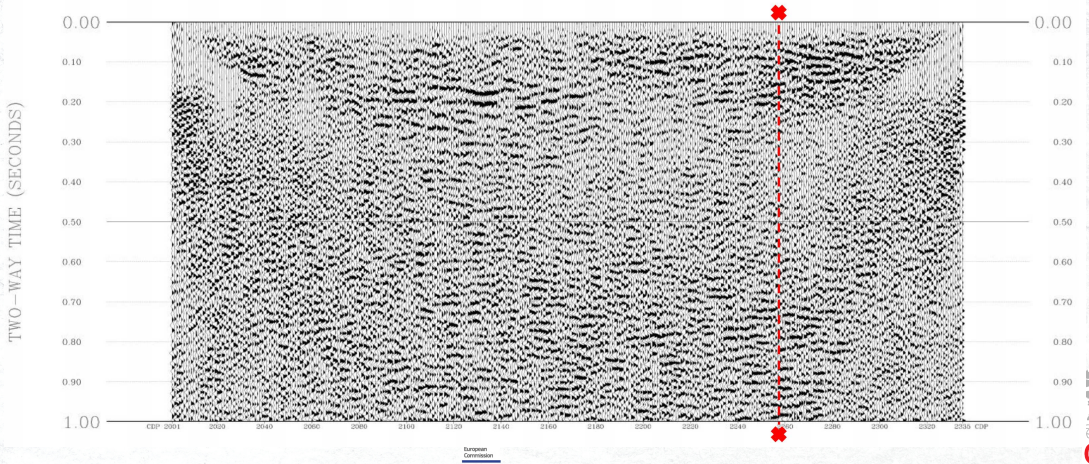
Line 2: WE Stack Section

Line 2CA



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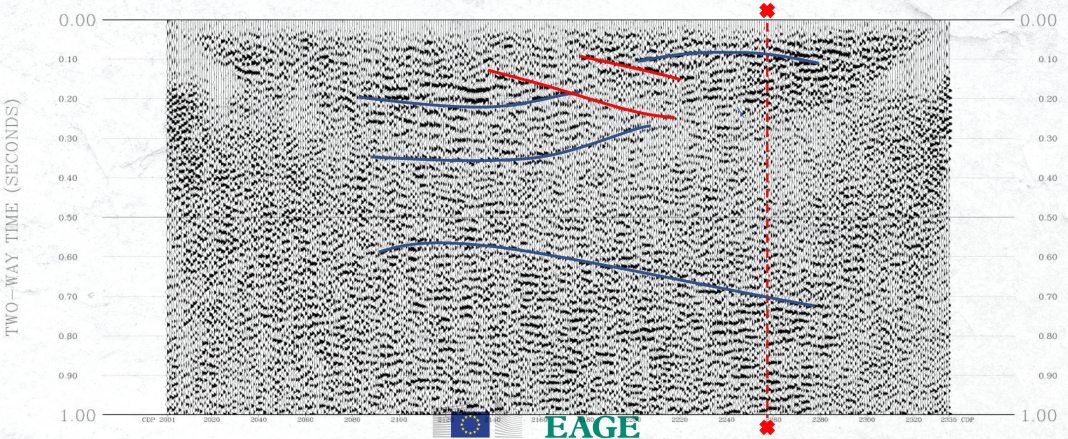
Line 2: WE Stack Section & Interpretation

Line 2CA



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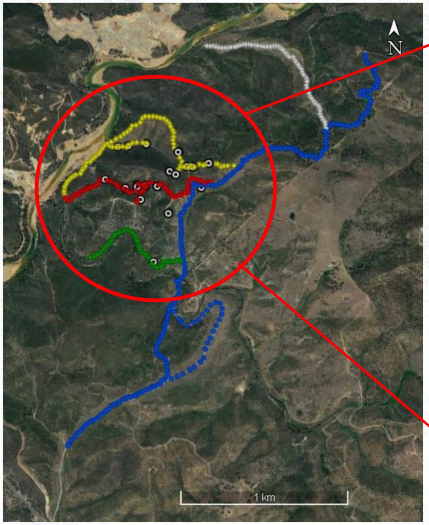
Borehole Exploration



87 Boreholes

19 points

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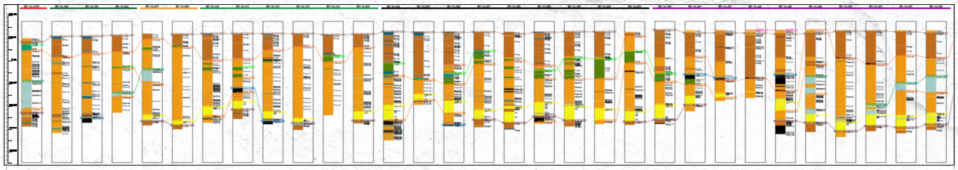
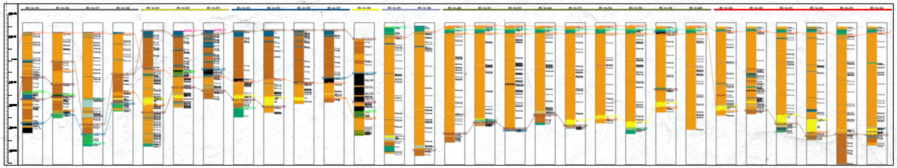
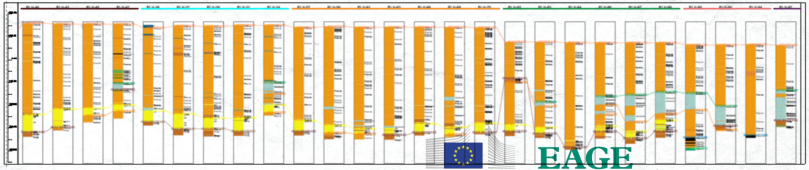
Density & Lithology







SM: 288-404 Mts

- Shales
- Dark shales
- SM y SSM
- Stockwork
- Andesite
- Green tufites
- Tuff and tuffites

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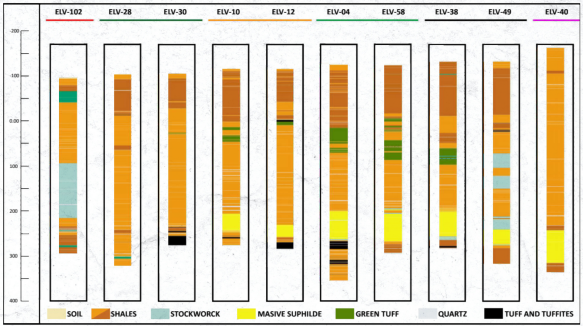
Density & Lithology Mapped Ore



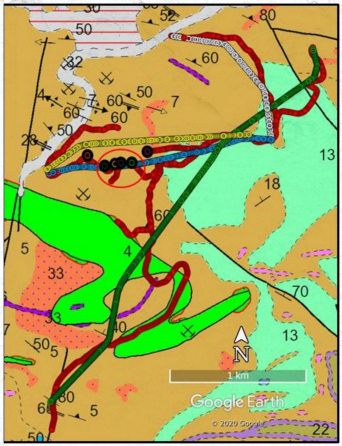
Quaternary	Antropics sediments Gravel, sand and sllt
Carboniferous	Tuff, tuffites and shales Purpel shales Jasper and cherts Basics Volcanics rocks and schist basics tuff Schist acid and intermadite tuff Intraformational gaps Limestone
Devonian	Shales, quartzwackes and quarzite

Intrusive rocks

Gabbro and diabasa

Simbology

- Estratification
- First schistocity
- Secomd schistocity
- Interseccion line
- Anticline axis (Fase 1)
- Anticline axis (Fase 2)
- Intrusive contact
- Discordant contact
- Inactive mine
- Faults



- ELV-102
- ELV-04 y ELV-58
- ELV-28 y ELV-30
- ELV-38 y ELV-49
- ELV-10 y ELV-12
- ELV-49

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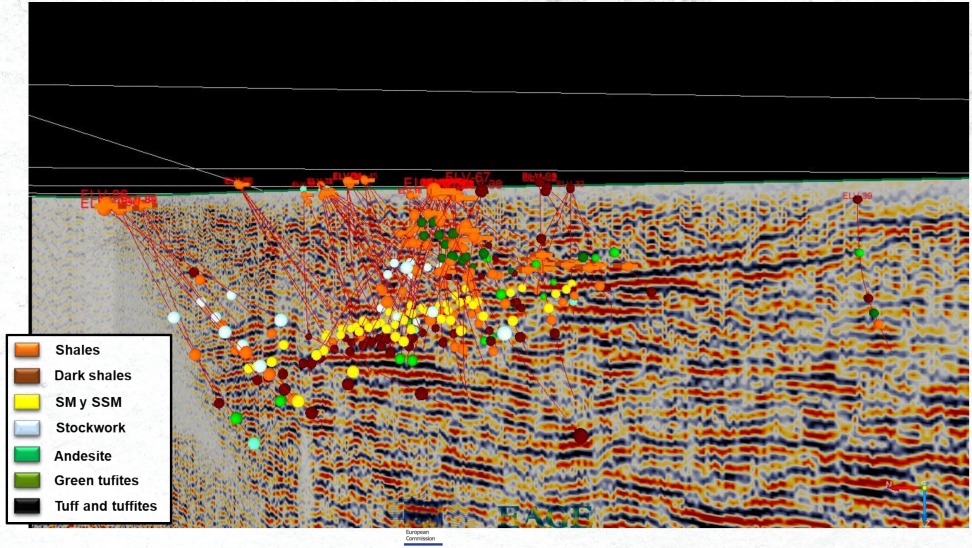
Integration Lithology & Seismics 3D



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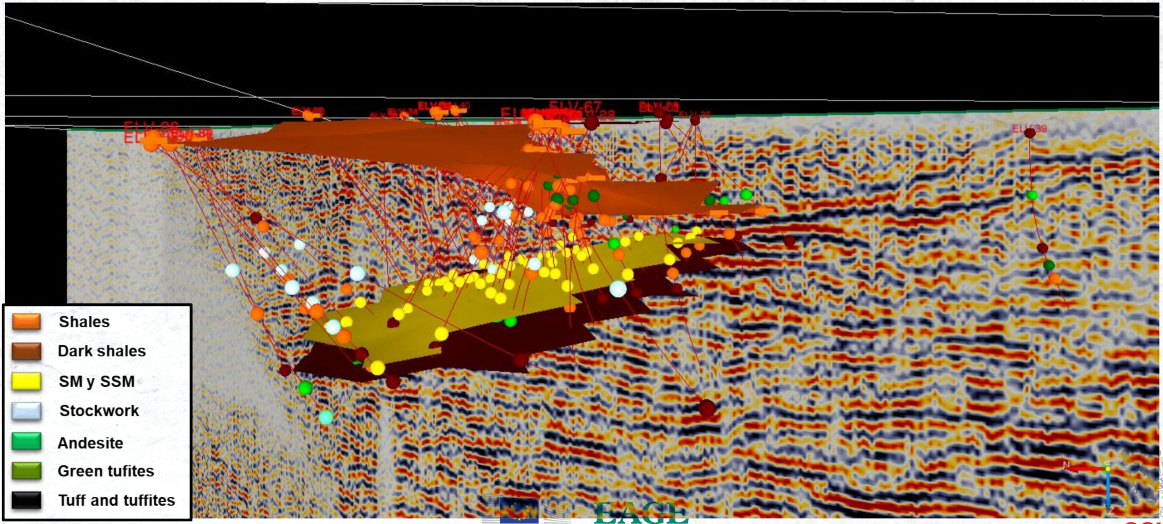
Projection shape of the Ore body



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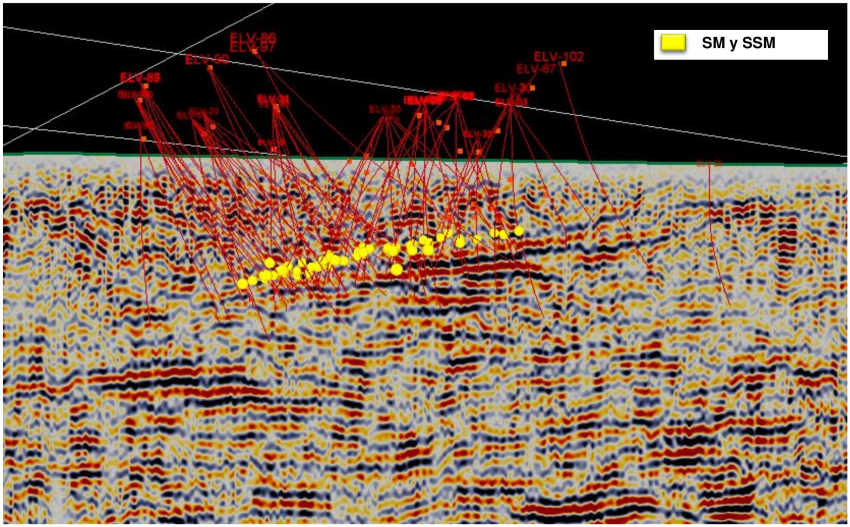
Lithology & Seismics 3D



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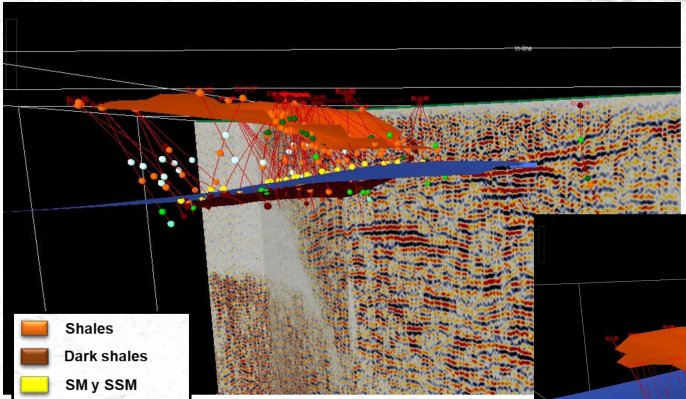
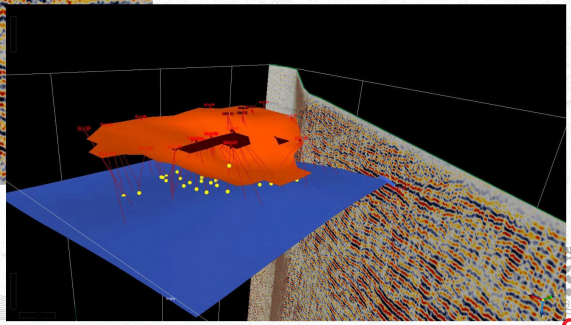
3D Interpretation

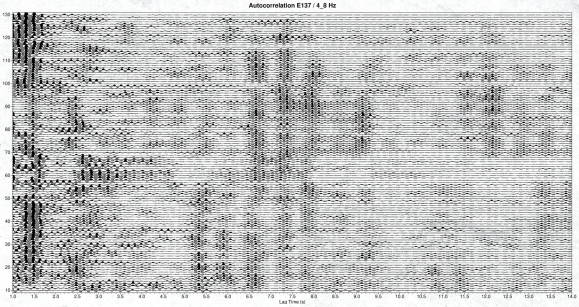


SM layer projection to Line N-S



Enviromental Seismic Noise Data Analysis

- Band Pass
- Autocorrelation step
- Stacking Phase Weighted Stack (daily)
- Approach by Schimmel et al., 2011 ; Schimmel et al., 2017



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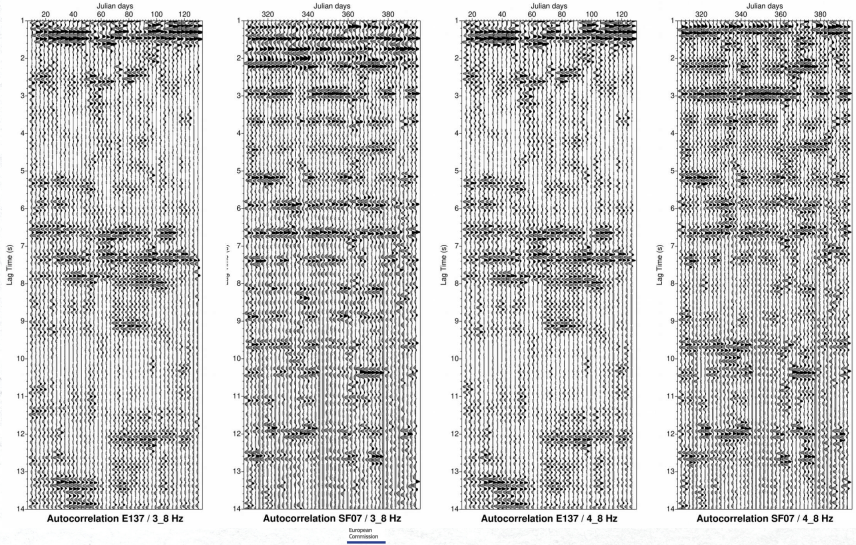
Daily Stacks (4-8 Hz), Preliminary results



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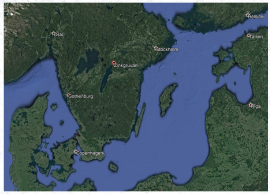
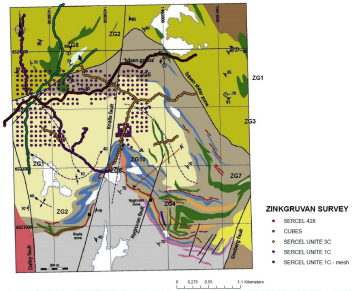
Pilot Site II, Zinkgruvan





Location & geometry of the data acquisition experiment

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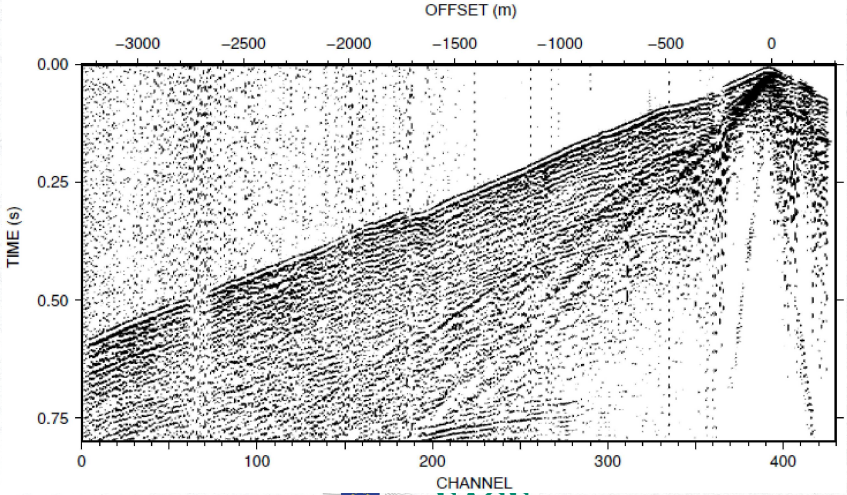
Pilot Site II, Shot Gather



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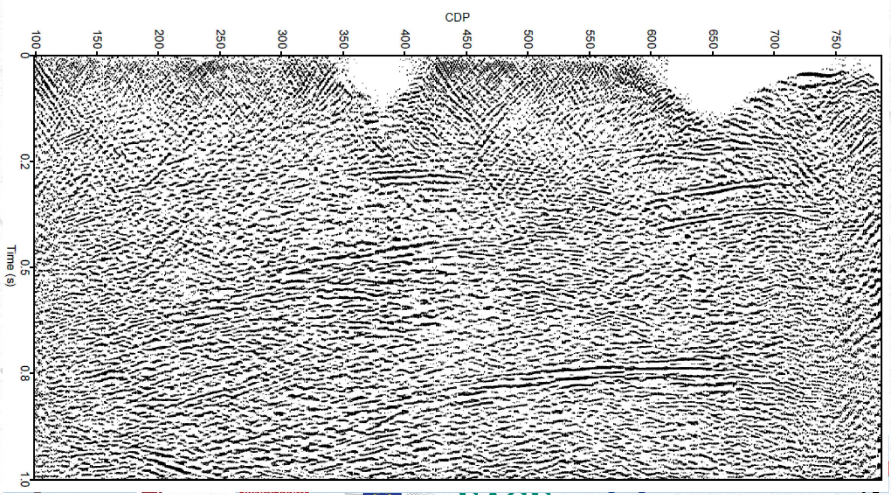
Pilot Site II, Preliminary Stack



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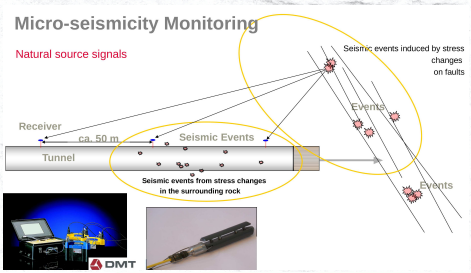
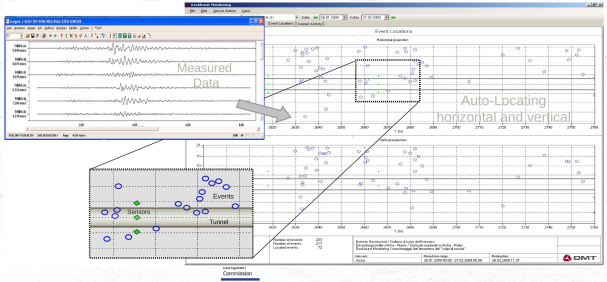
Natural Source Monitoring

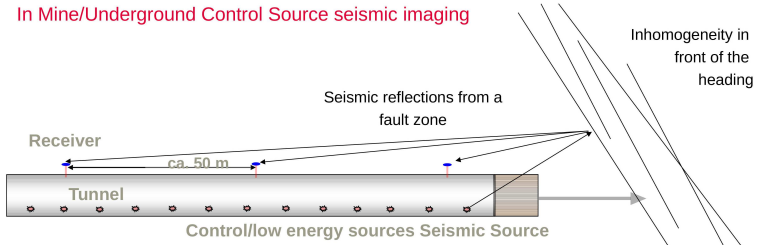


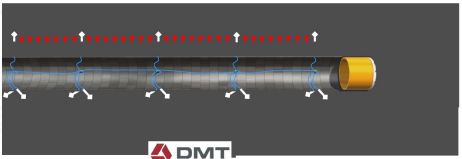


In Mine: Control Source

Seismic Exploration

In Mine/Underground Control Source seismic imaging





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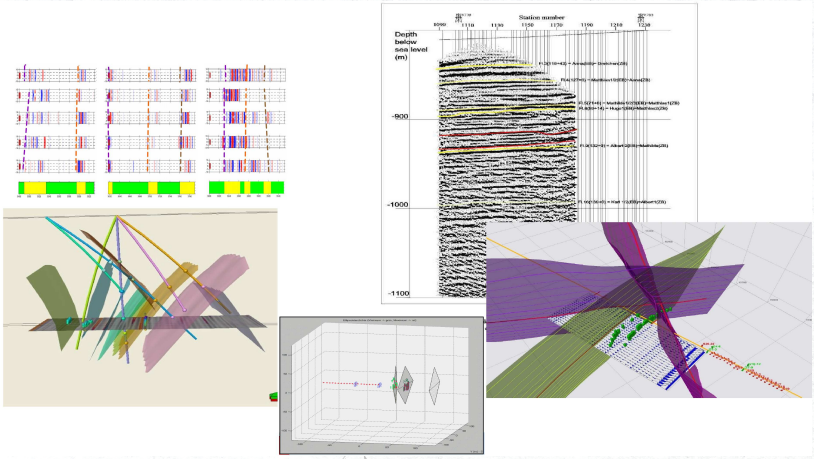
In Mine: Control Source Seismic Imaging



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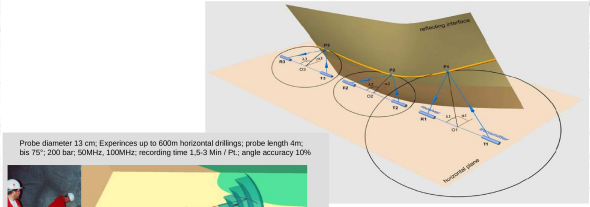
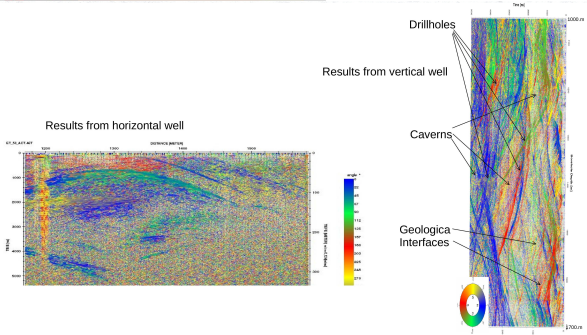
In Mine: GPR





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A Look Forward

- Seismic Processing
  - DMO, Pre-Stack Depth Migration,
  - 3D Seismic processing & modeling
  - Tomography (travel time inversion, Vs, Vp, FWI)
  - ...
- S-wave (3 Component recordings)
- Natural Source & ambient seismic noise analysis (Interferometry)

MINERAL EXPLORATION SYMPOSIUM

The End !!!

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